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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/767,657	01/29/2004	Chu-Yun Fu	677,200-1189	5383

7590 04/04/2005

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EXAMINER	
NOVACEK, CHRISTY L	
ART UNIT	**PAPER NUMBER**
2822	

DATE MAILED: 04/04/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/767,657	FU ET AL.	
	Examiner	Art Unit	
	Christy L. Novacek	2822	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *29 January 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-31* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-31* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

This office action is in response to the communication filed January 29, 2004.

Specification

The specification is objected to as failing to provide proper antecedent basis for the claimed subject matter. See 37 CFR 1.75(d)(1) and MPEP § 608.01(o). Correction of the following is required: Claim 16 recites the limitation of "silicon dioxide substantially free of stress in a direction substantially parallel or perpendicular to the semiconductor substrate major surface." The specification does not disclose forming silicon dioxide that is free of stress in a direction parallel or perpendicular to the substrate.

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 6, 8-11, 13-15 and 17-31 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

The last line of claim 6 recites, "consisting essentially of nitrogen (N_2) and is." It appears that there are additional limitations missing from this claim or the "and is" needs to be deleted from the claim.

Claim 13 recites the limitation of "the step of carrying out at least one thermal annealing step". There is insufficient antecedent basis for this limitation in the claim.

Claims 14 and 15 recite the limitation of "the step of etching a trench". There is insufficient antecedent basis for this limitation in the claims.

Claims 8-11 are rejected because their dependencies are inconsistent and indecipherable. Specifically, claim 8 is dependent upon claim 9, which is dependent upon claim 10. However, claim 10 is dependent upon claim 9. Claim 11 is also dependent upon claim 9. None of these claims are dependent upon an independent claim.

Claims 17-31 are rejected because their dependencies are inconsistent and indecipherable. Specifically, claims 17, 18, 21, 22 and 28-31 are dependent upon claim 19. However, claim 19 is also dependent upon claim 19. Claim 2 is dependent upon claim 22. Claims 23 and 25-27 are dependent upon claim 24. However, claim 24 is also dependent upon claim 24. None of these claims are dependent upon an independent claim.

Claims 6, 8-11 and 17-31 are being examined in so far as they can be understood. Claims 17-31 are being treated as though they are dependent upon claim 16.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 1-6, 12, 14-19 and 28 are rejected under 35 U.S.C. 102(b) as being anticipated by Ishitsuka et al. (US 6,242,323).

Regarding claim 1, Ishitsuka discloses providing a semiconductor substrate, forming a trench in the substrate, forming one or more liner layers to line the trench, forming one or more trench filling material layers with stress released material and removing excess trench filling material above the trench level (col. 2, ln. 54 – col. 3, ln. 3; col. 14, ln. 52 – col. 15, ln. 28).

Regarding claim 2, Ishitsuka discloses forming a patterned hardmask layer of silicon nitride over the substrate (col. 14, ln. 55-64).

Regarding claim 3, Ishitsuka discloses that the semiconductor substrate is made of silicon (col. 14, ln. 52-54).

Regarding claim 4, Ishitsuka discloses that the liner layer is forming by thermal oxidation (col. 17, ln. 43-47).

Regarding claim 5, Ishitsuka discloses that a chemical reactant that forming the liner layer can be O_2 or N_2O (col. 17, ln. 43-47; col. 28, ln. 4-11).

Regarding claim 6 in so far as the claim can be understood, Ishitsuka discloses treating the liner layer with nitrogen following the step of forming the line layer by a treatment of thermal anneal or ion implant of nitrogen (col. 27, ln. 59 – col. 28, ln. 29).

Regarding claim 12, Ishitsuka discloses an intermediate thermal annealing step following formation of the trench filling material layer (col. 15, ln. 11-22).

Regarding claims 14 and 17 in so far as these claims can be understood, Ishitsuka discloses forming the trench such that it has sidewalls having an angle with respect to a plane parallel to the substrate major surface of no more than 85 degrees (col. 7, ln. 37-39).

Regarding claims 15 and 18 in so far as these claims can be understood, Ishitsuka discloses forming a trench having a rounded top (Abstract).

Regarding claim 16, Ishitsuka discloses a semiconductor substrate, a trench formed through a thickness of the substrate, one or more liner material layers lining the trench, one or more trench filling material layers including silicon dioxide. Ishitsuka does not specifically disclose that the silicon dioxide layer is substantially free of stress in a direction substantially parallel or perpendicular to the substrate major surface. However, Ishitsuka states that an "object of the present invention is to provide a novel technique of reducing an adverse effect of stresses to an active region. Additionally, the sintering heat treatment process of Ishitsuka appears to be the same as the stress-reducing heat treatment process of Applicant's (e.g., both processes involve annealing silicon oxide at temperatures of around 1000°C in an oxidative atmosphere). Therefore, it appears that the silicon oxide trench fill material layer of Ishitsuka would inherently have the same stress profile as that of Applicant's. See *In re Swinehart*, 439 F.2d 210, 212-13, 169 USPQ 226, 229 (CCPA 1971) "where the Patent Office has reason to believe that a functional limitation asserted to be critical for establishing novelty in the claimed subject matter may, in fact, be an inherent characteristic of the prior art, it possesses the authority to require the applicant to prove that the subject matter shown to be in the prior art does not possess the characteristics relied on "); and *In re Fitzgerald*, 619 F.2d 67, 205 USPQ 594 (CCPA 1980) (a case indicating that the burden of proof can be shifted to the applicant to show that the subject matter of the prior art does not possess the characteristic relied on whether the rejection is based on inherency under 35 U.S.C. 102 or obviousness under 35 U.S.C. 103).

Regarding claim 19 in so far as the claim can be understood, Ishitsuka discloses that the trench fill material can have a portion that extends above the substrate (Fig. 21).

Regarding claim 28 in so far as the claim can be understood, Ishitsuka discloses that the liner material layers may be a SiO_2/SiN stack (col. 28, ln. 4-11).

Claims 1, 2, 4, 7, 8, 12, 13, 16, 19-21 and 23 are rejected under 35 U.S.C. 102(e) as being anticipated by Hong et al. (US 6,566,229).

Regarding claim 1, Hong discloses providing a semiconductor substrate (10), forming a trench in the substrate, forming one or more liner layers (15/17) to line the trench, forming one or more trench filling material layers (21/211/31/311) and removing excess trench filling material above the trench level (Fig. 1-5; col. 3, ln. 46 – col. 5, ln. 29). Hong does not specifically disclose that the trench filling material layer is formed of stress-released material. However, the heat treatment curing process of the SOG trench filling layer of Hong appears to be the same as the stress-reducing heat treatment process of Applicant's (e.g., both processes involve annealing SOG at temperatures of around 700-800°C in an oxidative atmosphere). Therefore, it appears that the SOG trench fill material layer of Hong would inherently have the same stress profile as that of Applicant's. See *In re Swinehart*, 439 F.2d 210, 212-13, 169 USPQ 226, 229 (CCPA 1971) "where the Patent Office has reason to believe that a functional limitation asserted to be critical for establishing novelty in the claimed subject matter may, in fact, be an inherent characteristic of the prior art, it possesses the authority to require the applicant to prove that the subject matter shown to be in the prior art does not possess the characteristics relied on "); and *In re Fitzgerald*, 619 F.2d 67, 205 USPQ 594 (CCPA 1980) (a case indicating that the burden of proof can be shifted to the applicant to show that the subject matter of the prior art

does not possess the characteristic relied on whether the rejection is based on inherency under 35 U.S.C. 102 or obviousness under 35 U.S.C. 103).

Regarding claim 2, Hong discloses forming a patterned hardmask layer of silicon nitride over the substrate (col. 3, ln. 46-50).

Regarding claim 4, Hong discloses that the liner layer is forming by thermal oxidation (col. 3, ln. 52-54).

Regarding claim 7, Hong discloses forming trench filling material layers by HDP-CVD and spin-coating processes (col. 3, ln. 57-59; col. 5, ln. 20-24).

Regarding claim 8 in so far as the claim can be understood, Hong discloses that the process of spin-coating involves forming an organic or inorganic precursor mixture for forming cross-linked silicon oxide containing structures (col. 3, ln. 57 – col. 4, ln. 55).

Regarding claim 12, Hong discloses an intermediate thermal annealing step following formation of the trench filling material layer (col. 15, ln. 11-22).

Regarding claim 13 in so far as the claim can be understood, Hong discloses that the thermal annealing step is carried out in an ambient of O_2 or N_2 (col. 4, ln. 47-55).

Regarding claim 16, Hong discloses a semiconductor substrate, a trench formed through a thickness of the substrate, one or more liner material layers lining the trench, one or more trench filling material layers including silicon dioxide. Hong does not specifically disclose that the silicon dioxide layer (formed by the evaporation of organic constituents in the SOG layer) is substantially free of stress in a direction substantially parallel or perpendicular to the substrate major surface. However, the heat treatment curing process of the SOG trench filling layer of Hong appears to be the same as the stress-reducing heat treatment process of Applicant's (e.g.,

both processes involve annealing SOG at temperatures of around 700-800°C in an oxidative atmosphere). Therefore, it appears that the silicon oxide layer formed by the SOG trench fill material layer of Hong would inherently have the same stress profile as that of Applicant's. See *In re Swinehart*, 439 F.2d 210, 212-13, 169 USPQ 226, 229 (CCPA 1971) "where the Patent Office has reason to believe that a functional limitation asserted to be critical for establishing novelty in the claimed subject matter may, in fact, be an inherent characteristic of the prior art, it possesses the authority to require the applicant to prove that the subject matter shown to be in the prior art does not possess the characteristics relied on "); and *In re Fitzgerald*, 619 F.2d 67, 205 USPQ 594 (CCPA 1980) (a case indicating that the burden of proof can be shifted to the applicant to show that the subject matter of the prior art does not possess the characteristic relied on whether the rejection is based on inherency under 35 U.S.C. 102 or obviousness under 35 U.S.C. 103).

Regarding claim 19 in so far as the claim can be understood, Hong discloses that the trench fill material can have a portion that extends above the substrate (Fig. 5).

Regarding claim 20 in so far as the claim can be understood, Hong discloses that the portion of the trench filling material layer above the substrate surface includes an inward edge portion extending higher above the substrate than an outward edge portion (Fig. 5).

Regarding claim 21 in so far as the claim can be understood, Hong discloses that the trench filling material layer may include organic or inorganic SOG or USG (col. 3, ln. 57 – col. 4, ln. 55).

Regarding claim 23 in so far as the claim can be understood, Hong discloses that the trench filling material layers include a lowermost organic or inorganic SOG layer and an uppermost USG layer.

Claims 1-4, 7, 8, 12, 16, 19-21, 23-25 and 28 are rejected under 35 U.S.C. 102(e) as being anticipated by Heo et al. (US 6,683,354).

Regarding claim 1, Heo discloses providing a semiconductor substrate (10) forming a trench in the semiconductor substrate, forming one or more liner layers (19/15) to line the trench, forming one or more trench filling material layers (17/21/23/25) and removing excess trench filling material above the trench level (Fig. 1-6; col. 3, ln. 20 - col. 4, ln. 56). Heo does not specifically disclose that the trench filling material layers include a stress released material. However, the heat treatment curing process of the SOG trench filling layer of Heo appears to be the same as the stress-reducing heat treatment process of Applicant's (e.g., both processes involve annealing SOG at temperatures of around 700-800°C in an oxidative atmosphere). Therefore, it appears that the SOG trench fill material layer of Heo would inherently have the same stress profile as that of Applicant's. See *In re Swinehart*, 439 F.2d 210, 212-13, 169 USPQ 226, 229 (CCPA 1971) "where the Patent Office has reason to believe that a functional limitation asserted to be critical for establishing novelty in the claimed subject matter may, in fact, be an inherent characteristic of the prior art, it possesses the authority to require the applicant to prove that the subject matter shown to be in the prior art does not possess the characteristics relied on "); and *In re Fitzgerald*, 619 F.2d 67, 205 USPQ 594 (CCPA 1980) (a case indicating that the burden of proof can be shifted to the applicant to show that the subject matter of the prior art

does not possess the characteristic relied on whether the rejection is based on inherency under 35 U.S.C. 102 or obviousness under 35 U.S.C. 103).

Regarding claim 2, Heo discloses forming a patterned hardmask layer (13) of silicon nitride (col. 3, ln. 20-25).

Regarding claim 3, Heo discloses that the substrate is silicon (col. 3, ln. 20-21).

Regarding claim 4, Heo discloses that the liner layer is made by thermal oxidation and LPCVD (col. 3, ln. 34-47).

Regarding claim 7, Heo discloses that the step of forming the trench filling material layers includes a spin-coating and HDP-CVD process (col. 4, ln. 9 – col. 5, ln. 13).

Regarding claim 8 in so far as the claim can be understood, Heo discloses that the process of spin-coating includes forming a spin-on-glass (SOG) comprising a precursor of organic and inorganic materials for forming cross-linked silicon oxide containing structures (col. 4, ln. 9-40).

Regarding claim 12, Heo discloses carrying out intermediate thermal annealing steps following formation of trench filling material layers (col. 4, ln. 25-48).

Regarding claim 16, Heo discloses a semiconductor substrate, a trench formed through a thickness of the substrate, one or more liner material layers lining the trench, one or more trench filling material layers including silicon dioxide. Heo does not specifically disclose that the silicon dioxide layers are substantially free of stress in a direction substantially parallel or perpendicular to the substrate major surface. However, the heat treatment curing process of the silicon dioxide trench filling layer of Heo appears to be the same as the stress-reducing heat treatment process of Applicant's (e.g., both processes involve annealing SOG at temperatures of around 700-800°C in an oxidative atmosphere). Therefore, it appears that the SOG trench fill

material layer of Heo would inherently have the same stress profile as that of Applicant's. See *In re Swinehart*, 439 F.2d 210, 212-13, 169 USPQ 226, 229 (CCPA 1971) "where the Patent Office has reason to believe that a functional limitation asserted to be critical for establishing novelty in the claimed subject matter may, in fact, be an inherent characteristic of the prior art, it possesses the authority to require the applicant to prove that the subject matter shown to be in the prior art does not possess the characteristics relied on "); and *In re Fitzgerald*, 619 F.2d 67, 205 USPQ 594 (CCPA 1980) (a case indicating that the burden of proof can be shifted to the applicant to show that the subject matter of the prior art does not possess the characteristic relied on whether the rejection is based on inherency under 35 U.S.C. 102 or obviousness under 35 U.S.C. 103).

Regarding claim 19 in so far as the claim can be understood, Heo discloses that the trench filling material layers includes a portion that extends above the semiconductor substrate (Fig. 6).

Regarding claim 20 in so far as the claim can be understood, Heo discloses that the portion of trench filling material layers above the semiconductor substrate includes an inward edge portion extending higher above the substrate surface than an outward edge portion (Fig. 6).

Regarding claim 21 in so far as the claim can be understood, Heo discloses that the trench filling material includes inorganic spin-on glass and USG (col. 4, ln. 9 – col. 5, ln. 13).

Regarding claim 23 in so far as the claim can be understood, Heo discloses that the trench filling material includes a lowermost inorganic SOG layer and an uppermost USG layer (col. 4, ln. 9 – col. 5, ln. 13).

Regarding claim 24 in so far as the claim can be understood, Heo discloses that the trench filling material include a lowermost USG layer (17), an intervening inorganic SOG layer, and an uppermost USG layer (col. 3, ln. 49 – col. 5, ln. 13).

Regarding claim 25 in so far as the claim can be understood, Heo discloses that the trench filling material includes a plurality of USG layers.

Regarding claim 28 in so far as the claim can be understood, Heo discloses that the liner material layers are formed of a SiO_2/SiN stack.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 9 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hong et al. (US 6,566,229) in view of Cui et al. (US 6,693,050).

Regarding claims 9 and 11 in so far as the claims can be understood, Hong discloses depositing a silicon oxide layer by either HDP-CVD (col. 5, ln. 20-29). However, Hong does not disclose any particular precursors/reactants to be used to form the layer. Like Hong, Cui discloses a process of depositing a silicon oxide layer in a STI. Cui teaches that the silicon oxide layer can be successfully deposited using HDP-CVD with reactants of silane (SiH_4) and O_2 (col. 5, ln. 20-23). At the time of the invention, it would have been obvious to one of ordinary skill in the art to use silane and oxygen as the reactants to form the silicon oxide layer Hong because Hong does not disclose any particular reactants and Cui discloses that these reactants can successfully be used in a HDP-CVD process to deposit silicon oxide in a STI.

Claims 1-4, 7, 9, 10, 12, 16, 19-22 and 25-28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ahn (US 6,596,607) in view of Oyamatsu (US 6,261,920).

Regarding claim 1, Ahn discloses providing a semiconductor substrate (100), forming a trench in the substrate, forming one or more liner layers (105/107) to line the trench, forming one or more trench filling material layers (109/129/139) and removing excess trench filling material above the trench level (Fig. 5-10; col. 4, ln. 3 – col. 5, ln. 6). Ahn does not disclose forming the trench filling material layer of stress-released material. Like Ahn, Oyamatsu discloses a process of depositing a silicon oxide trench filling material into a STI. Oyamatsu discloses that it is conventional in the art to anneal the silicon oxide layer in order to reduce the film stress of the layer (col. 2, ln. 43-45; col. 12, ln. 17-20). At the time of the invention, it would have been obvious to one of ordinary skill in the art to anneal the silicon oxide layer of Ahn because Oyamatsu discloses that it is conventional to do so for the purpose of reducing the film stress of the layer.

Regarding claim 2, Ahn discloses forming a patterned hardmask layer of silicon nitride over the substrate (col. 4, ln. 3-5).

Regarding claim 3, Ahn discloses that the semiconductor substrate is made of silicon (col. 4, ln. 3-5).

Regarding claim 4, Ahn discloses that a liner layer may be formed by thermal oxidation (col. 4, ln. 15-18).

Regarding claim 7, Ahn discloses forming trench filling material layers by LPCVD (equivalent to SACVD) and SOG and HDP-CVD (col. 4, ln. 20-31).

Regarding claims 9 and 10 in so far as these claims can be understood, Ahn discloses forming a trench filling material layer by CVD using reactants of TEOS (a silane) and O_3 (col. 5, ln. 2). However, Ahn does not specify which type of CVD is used to deposit the layer. At the time of the invention, it would have been obvious to one of ordinary skill in the art to use a LPCVD (SACVD) process to deposit the trench filling material layer of Ahn because it is well-known in the art that LPCVD produces films which are superior in conformability and purity as compared to other types of CVD.

Regarding claim 12, for the reasons discussed above in reference to claim 1, it would have been obvious to one of ordinary skill in the art to anneal the trench filling material layer of Ahn.

Regarding claim 16, Ahn discloses a semiconductor substrate, a trench formed through a thickness of the semiconductor substrate, one or more liner layers lining the trench, and one or more trench filling material layers including silicon dioxide (col. 4, ln. 3 – col. 5, ln. 6). Ahn does not disclose forming the silicon dioxide such that it is substantially free of stress in a direction parallel or perpendicular to the surface of the substrate. Like Ahn, Oyamatsu discloses a process of depositing a silicon oxide trench filling material into a STI. Oyamatsu discloses that it is conventional in the art to anneal the silicon oxide layer in order to reduce the film stress of the layer (col. 2, ln. 43-45; col. 12, ln. 17-20). At the time of the invention, it would have been obvious to one of ordinary skill in the art to anneal the silicon oxide layer of Ahn because Oyamatsu discloses that it is conventional to do so for the purpose of reducing the film stress of the layer.

Regarding claim 19 in so far as the claim can be understood, Ahn discloses that the trench fill material can have a portion that extends above the substrate (Fig. 10).

Regarding claim 20 in so far as the claim can be understood, Ahn discloses that the portion of the trench filling material layer above the substrate surface includes an inward edge portion extending higher above the substrate than an outward edge portion (Fig. 10).

Regarding claim 21 in so far as the claim can be understood, Hong discloses that the trench filling material layer may include USG or SOG (inherently, SOG must be either organic or inorganic) (col. 4, ln. 20 – col. 5, ln. 3).

Regarding claim 22, Ahn discloses that the trench filling material layers may include a silicate (TEOS).

Regarding claim 25, Ahn discloses that the trench filling material layers may include a plurality of USG layers (col. 4, ln. 20 – col. 5, ln. 3).

Regarding claim 26, Ahn discloses that the trench filling material layers may include a plurality of SOG layers (inherently, SOG must be either organic or inorganic) (col. 4, ln. 20 – col. 5, ln. 3).

Regarding claim 27, Ahn discloses that the trench filling material layers may include an uppermost SOG layer (inherently, SOG must be either organic or inorganic) (col. 4, ln. 20 – col. 5, ln. 3).

Regarding claim 28, Ahn discloses that the liner material layers may be formed of a SiO_2/SiN stack (col. 4, ln. 15-19).

Claims 29-31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Heo et al. (US 6,683,354).

Regarding claims 29-31, Heo discloses forming a liner layer of SiO_2, a liner layer of SiN on top of the SiO_2 and another SiO_2 layer on top of the SiN layer. At the time of the invention, it would have been obvious to one of ordinary skill in the art that during the high-temperature anneal steps taught by Heo, some nitrogen atoms within the SiN layer are going to diffuse into the surrounding SiO_2 layers, thus creating various strata of SiO_2, SiN and SiON layers within the trench and with each anneal step, the strata of layers will change as additional nitrogen atoms are diffused.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Christy L. Novacek whose telephone number is (571) 272-1839. The examiner can normally be reached on Monday-Thursday and alternate Fridays 7:30 - 5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Amir Zarabian can be reached on (571) 272-1852. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

CLN
March 31, 2005

AMIR ZARABIAN
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800